Alaska Small Remote Incinerator Testing Program

Summary
Small remote incinerators (SRIs) in Alaska are employed to quickly dispose of putrescible wastes and for the efficient management of other municipal type wastes such as office, camp, construction, and wastewater treatment plant wastes. The quick disposal of much of the waste is an integral part of programs in remote Alaska put in place for the purpose of minimizing impacts to wildlife.

Each of the waste types combusted in SRIs have unique combustion characteristics and emissions that vary. As such, each incinerator's emission characteristics and emission rates are determined by:

1. What types of these wastes are burned and how they are fed into the unit (batch or continuously);
2. How long they are burned;
3. The auxiliary fuel employed; and,
4. Where in the burn cycle emissions measurements are collected.

These determining factors, or methods of operation, are very different among the Alaska small remote incinerator operators and this was not taken into account in the course of establishing emission limits under 40 CFR 60, Subparts CCCC and DDDD, the *Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Commercial and Industrial Solid Waste Incineration Units* (CISWI). The compliance difficulty and large uncertainty with which this leaves Alaska small remote incinerator operators are detailed in the petition for reconsideration submitted by AOGA, ConocoPhillips, and the Alaska Miners Association on April 8, 2013.

We propose to implement this program to define these variables across SRIs for the purpose of establishing statistically defensible emission limits. From this program we may discern the need for further SRI sub-categorization and different emissions averaging periods for compliance demonstrations.

Program Overview
The program proposed consists of a two-phase testing program conducted over the years 2013-2015. The first phase of the testing program, to be conducted in 2013 and 2014, is to establish the different emission characteristics and profiles of the differently operated units. In this phase, emissions from 6-10 incinerators will be quantified over their entire burn cycle in order to:

1. Determine the impact to emissions from batch feeding vs. semi-continuous feeding;
2. Determine the impact of different wastes on emissions;
3. Determine the impact on emissions from using different auxiliary fuels;
4. Determine the impact on emissions from including sewage sludge in the waste stream; and
5. Assess the differences between incinerators used in different industries.

This information will be used to establish a testing regimen that will generate representative emissions data, including the appropriate averaging period for each pollutant. This testing regimen will be documented as the Phase 2 Protocol and will be submitted to EPA for approval near the end of calendar year 2014. Upon approval, which is necessary by the end of the first quarter of 2015, Phase 2 will be carried out in the summer of 2015, the results summarized, emission limits proposed, and all submitted to EPA by the end of the first quarter of 2016. In this document, we discuss only the Phase 1 Protocol. This is a draft protocol we expect to develop further after consultation with EPA and as we develop additional technical knowledge as well as enhanced understanding of SRI operations.

PHASE 1 PROTOCOL

This protocol's purpose is to characterize the small remote incinerator (SRI) emissions profiles and evaluate the proper method to test for emissions unit compliance among them. This protocol is not intended to be used for the purpose of complying with federal or state environmental regulations. The procedure for assessing compliance with the CISWI emission limits will be developed as part of Phase 2 of this program. There are three essential components to this protocol, which are intended to be executed concurrently.

The three components of the program are:

1. Emissions Sampling and Analysis;
2. Waste Feed Sampling and Characterization; and,
3. Incinerator Operations Monitoring.

This protocol is intended to be adapted to site-specific considerations as well as any new information that surfaces in the process of its implementation. The objective with each test conducted pursuant to this Phase 1 Protocol is to gather data that is representative and that can be used for statistical analysis.

Because of the considerations in Sections 1 through 4, below, it is critical that a Phase 1 testing plan be developed by each facility and reviewed by our statisticians prior to carrying out the testing. The test plan should detail how the incinerator will be operated and monitored during the testing, the testing duration, how the wastes will be characterized and sampled, and the testing quality assurance and quality control (QA/QC).

1.0 UNITS TO TEST

Based upon a query of small remote incinerator operators (see Table 1), at least one unit in the following eight categories is targeted for testing in Phase 1:

1) Oil and Gas operated incinerators using gas as auxiliary fuel and incinerating sludge
2) Oil and Gas operated incinerators using gas as auxiliary fuel and not incinerating sludge
3) Oil and Gas operated incinerators using diesel as auxiliary fuel and incinerating sludge
4) Oil and Gas operated incinerators using diesel as auxiliary fuel and not incinerating sludge
5) Mining operated incinerators using gas as auxiliary fuel and incinerating sludge

6) Mining operated incinerators using gas as auxiliary fuel and not incinerating sludge
7) Mining operated incinerators using diesel as auxiliary fuel and incinerating sludge
8) Mining operated incinerators using diesel as auxiliary fuel and not incinerating sludge

We propose to test these distinct categories of incinerators for the following reasons:

- Incinerators in the mining industry likely exhibit statistically significant emissions differences from those in other industries because of the metals they may contain.
- It is well established by EPA that diesel and gas (natural gas and propane) fuels exhibit significant differences in NOx, SO_2, and PM emissions.
- Preliminary data indicates the addition of sewage sludge to an incinerated waste stream can significantly affect the NOx, CO, and metals emissions.

We do not, at this point, propose these as small remote incinerator subcategories. Rather, we propose to develop the emission characteristics of incinerators within these categories in order to assess whether such sub-categorization is warranted.

Table 1: Summary of Physical and Operational Characteristics of Alaska SRIs

COMPANY	UNIT ID	BATCH OPERATED?	INCINERATOR DESIGN RATING	SECONDARY COMBUSTION CHAMBER?	BURNER SIZE(S)?	AUXILIARY FUEL	SLUDGE?
XTO Energy	Therm-Tec G30	Yes	475 lb/hr/batch;	Yes	0.8 MM BTU/hr main 1.6 MM BTU/hr secondary	Natural gas	No
ConocoPhillips	Alpine #1	Yes	3.5 ton/day design;	Yes	1.36 MM BTU/hr primary 2.2 MM BTU/hr secondary	Natural gas	Yes
ConocoPhillips	Alpine #2	Yes	3.5 ton/day design;	Yes	1.36 MM BTU/hr primary 2.2 MM BTU/hr secondary	Natural gas	Yes
ConocoPhillips	Kuparuk #1	No	1300 lbs/hr	Yes	1.6 MMBTU/hr primary: 2.0 MMBTU/hr seconday	Natural Gas	Yes
ConocoPhillips	Kuparuk #2	No	900 lbs/hr	Yes	1.95 MMBTU/hr primary: 1.33 MMBTU/hr seconday	Natural Gas	Yes
Alyeska	Pump Station 5	Yes	300 lb/hr	Yes	Primary 0.8 MM BTU/hr Secondary 1.6 MM BTU/hr	Diesel fuel	No
BPX	Northstar	Yes	100 lb/hr	Yes	Main 0.8 MM BTU/hr Secondary 1.1 MM BTU/hr	Natural gas	No
Pioneer Natural Resources		Yes	121 lb/hr(33lb/batch); 1210 lb/day (10 hr/day rated operation)	Yes	Primary 0.75 MM BTU/hr Secondary 1.8 MM BTU/hr	Diesel fuel	No
Teck Alaska Inc.	Red Dog Main	Yes	900 lb/hr	Yes	Primary 0.685 MM btu/hr Secondary 0.959 MM BTU/hr	Diesel	No
Teck Alaska Inc.	Red Dog Backup	Yes	625 lb/hr	Yes	Primary 0.548 MM BTU/hr Secondary 0.685 MM BTU/hr	Diesel	No
Teck Alaska Inc.	Red Dog Port Site	Yes	300 lb/hr	Yes	Primary 0.548 MM BTU/hr Secondary 0.685 MM BTU/hr	Diesel	Yes
Hilcorp	Drift River	Yes	170 lb/batch;	Yes	Total 0.560 MM BTU/hr	Diesel (ULSD)	No

COMPANY	UNIT ID	BATCH OPERATED?	INCINERATOR DESIGN RATING	SECONDARY COMBUSTION CHAMBER?	BURNER SIZE(S)?	AUXILIARY FUEL	SLUDGE?
Hilcorp	Swanson River	Yes	150 lb/hr	Yes	Model line Rated 100 K BTU/hr minimum; 800 K BTU/hr maximum; no data on this particular unit	Natural gas	No
Donlin Gold, LLC	Donlin Gold Camp	Yes	1000 lbs/day.	Yes	Unknown	None	No
Couer Alaska	Kensington Gold Mine, Juneau AK, Berners Bay	Yes	500 lb/hr	Yes	Primary and Secondary – 770,000 BTU/hr	Diesel	No
ENI	EU 96	Yes	300 lb/hr	Yes	2 primary chamber burners = 945,000 btu each Secondary chamber burner = 1,900,000 btu	Natural gas	No
ENI	EU 48	Yes	300 lb/hr	Yes	2 primary chamber burners = 945,000 btu each Secondary chamber burner = 1,900,000 btu	Natural Gas	No
Sutimoto Metals	Pogo New	Yes	480 lb/hr	Yes	Primary and secondary both 800,000 BTU/hr	Propane	Yes
Sutimoto Metals	Pogo Old	Yes	1.3 ton/day	Yes	Primary and secondary both 0.77 MMBTU/hr	Diesel	Yes
Hecla Greens Creek		Yes	130 lb/hr waste per 8 hours in a 24-hour period	Yes	Becket burners are rated at 350,000 and 250,000 BTU/hr	#2 fuel oil	No
Hilcorp	Trading Bay	Yes	1600 lb/day	Yes	Primary 800,000 BTU max; 100,000 BTU min Secondary: 800,000 BTU max; 100,000 BTU min	Natural Gas	No
Chugach Electric	Beluga River Power Plant	Yes	Nameplate rating 300 lb/hr	Yes	Primary 0.8 MM BTU; Secondary Unknown	Natural Gas	No

1.1 INCINERATOR OPERATION DURING EMISSIONS SAMPLING

Because the CISWI emission standards are to apply during periods of startup, shutdown, and malfunction, this test program will be designed to include all portions of the batch incinerator process. For a 12 hour batch cycle or daily operational period, the planned testing program will require 12-14 hours of source testing each day (shorter time frames for units with shorter burn cycles or daily operating periods), and this duration should encompass one daily startup and a portion of the shutdown process. In the event of an incinerator malfunction sampling should not be stopped. Any malfunctions during sampling should be used as an opportunity to collect data during this condition.

During the emissions sampling, the SRI should be run with conditions representative of normal operations. Additionally, the wastes burned during the testing should be those normally combusted at the facility as this will yield the most representative and useful emissions data. It is very important that sewage sludge, if normally burned at a facility, be available in representative amounts over the period of testing.

1.2 EMISSIONS TEST METHODS TO BE USED

This testing program will use emissions source testing methods from 40 CFR 60 Appendix A and 40 CFR 51 Appendix M. This testing will use the same reference test methods as the CISWI test programs conducted on Alaska incinerators in 2009 as part of an EPA Section 114 Information Collection Request.

For developing the profiles for comparison, each of the incinerators is recommended to be tested for the following parameters:

- gas velocity and temperature using EPA Methods 1 and 2
- oxygen (O2) and carbon dioxide (CO2) using EPA Method 3A
- moisture using EPA Method 4
- filterable particulate matter using EPA Method 5
- sulfur dioxide (SO2) using EPA Method 6C
- nitrogen oxides using EPA Method 7E
- carbon monoxide (CO) using EPA Method 10
- dioxins (PCDD) and furans (PCDF) using EPA Method 23
- hydrogen chloride (HCl) using EPA Method 26A
- cadmium (Cd), lead (Pb), and mercury (Hg) using EPA Method 29

The minimum recommended durations for each emission sampling period are presented in Table 2.

Table 2: Recommended Minimum Durations for Emissions Sampling

POLLUTANT	TEST METHOD	MINIMUM TEST RUN DURATION(A)	TARGET EMISSION REPORTING UNITS
Particulate	Method 5	1.75 hours	mg/dscm
HCl	Method 26A	1.5 hours	ppmvd @ 7%O2
Cd, Pb, & Hg	Method 29	5 hours	mg/dscm
Cd, Pb, & Hg	Method 29	1.75 Hours	mg/dscm
Dioxin/Furan	Method 23	4 hours	ng/dscm (total & TEQ)
SO2	Method 6C	Burn cycle (B), hourly	ppmvd @ 7%O2
NOx	Method 7E	Burn cycle, hourly	ppmvd @ 7%O2
CO	Method 10	Burn cycle, hourly	ppmvd @ 7%O2

(A) Minimum sampling times may require adjustment for shorter burn cycles.
(B) For true batch units, the gaseous pollutant emissions should be measured continuously over the entire duration of the incineration process. Some analyzer downtime is expected to allow for drift checks and calibration.

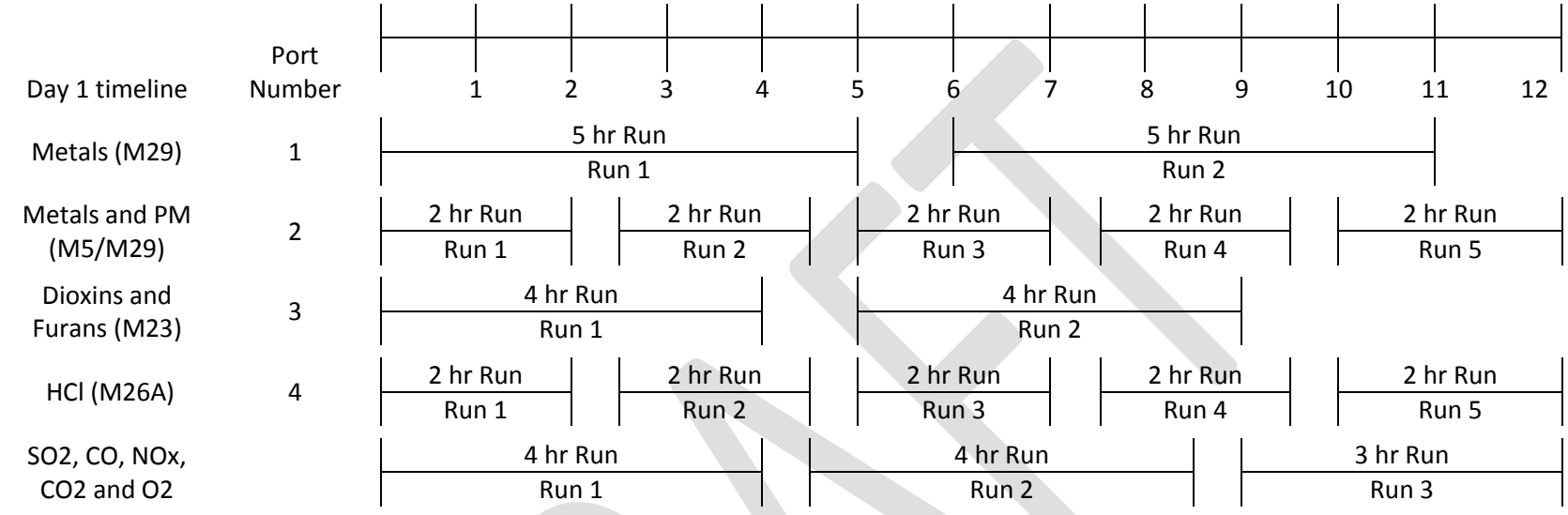
1.3 EMISSIONS TEST INCINERATOR OPERATION SYNCHRONIZATION

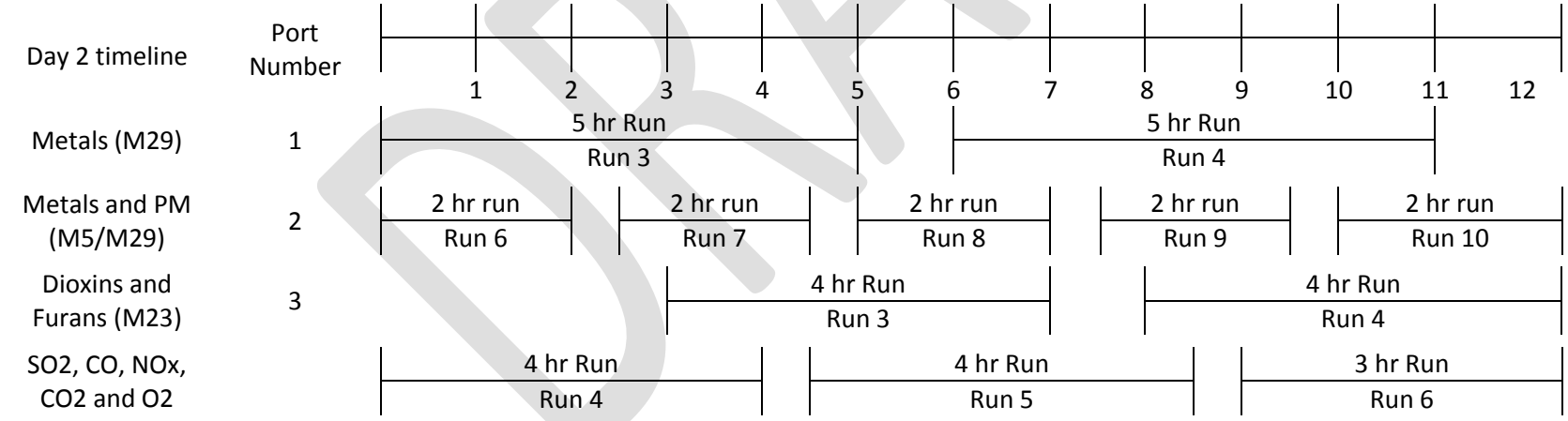
The incinerators included in this test program have varying lengths of burn cycles and hours of daily operation. The goal is to capture emissions throughout the burn cycle, from startup, through charge (or multiple charges), and to shutdown. Deviation from the standard 3 run format of emission tests may be required to capture emissions throughout the entire operating cycle of the incinerator. This may also increase statistical confidence in the results of the tests. A customized schedule matched to the burn cycle for each participating facility must be established in advance of any testing. Semi-continuous feed units, for example, should select a testing length corresponding to a discrete number of feed occurrences. Two example schedules matching an incinerator operating for 12 hours and 4 hours, respectively, are included on the next page.

The first test run of each day will begin when the incinerator is initially charged with waste in the morning. Emissions testing will occur over the entire burn cycle for true batch units and, for semi-continuously fed units,[1] will continue throughout subsequent waste charges and waste burn down periods. Testing should not be halted for any waste charges or any noted incinerator malfunctions. The second test run and any subsequent test runs in the same operating day will be conducted starting with the incinerator already burning waste, and may include additional waste charges during the test run.

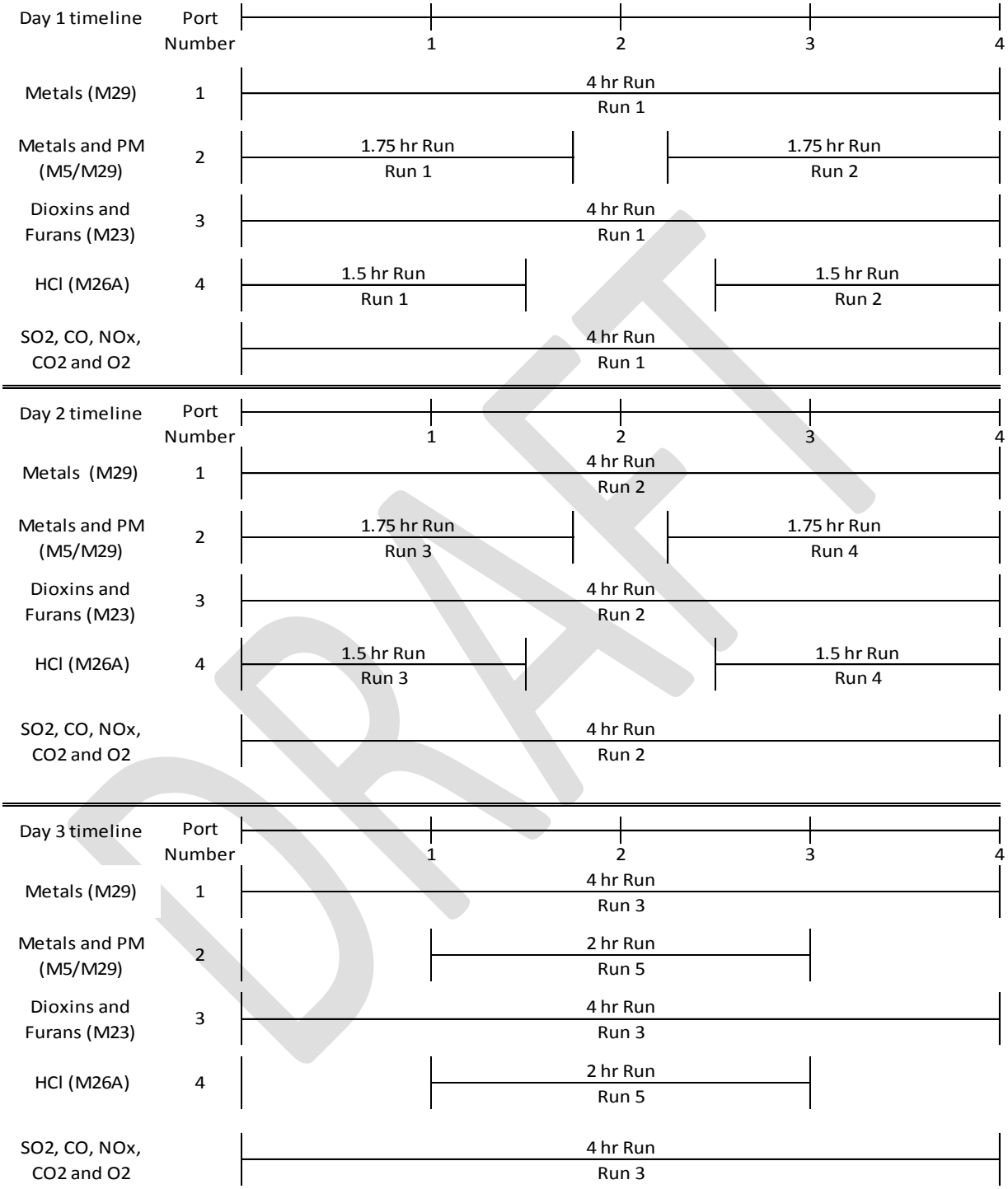
[1] A true batch fed unit is one where the waste is charged and is allowed to be completely combusted to ash, and the ash removed, before any new waste is charged. A semi-continuously fed unit is one where waste is charged periodically without regard to whether or not the previous batch is completely combusted.

12 Hour Operation Example Emission Testing Schedule Based on Four Ports





4 Hour Operation Example Testing Schedule Based on Four Ports



1.4 EMISSIONS TEST METHOD APPLICATION NOTES

A number of the test methods used for this test protocol have specific application considerations or notes. The table below outlines many of the key considerations in applying the individual test methods. This listing does not attempt to summarize the testing methodology or analysis methods, but provides clarification on how specific test methods should be applied during tests that use this protocol.

Table 3: Method Application Notes

POLLUTANT	TEST METHOD	APPLICATION NOTES
Particulate	Method 5	• Although the 2009 CISWI source tests were conducted using OTM-28 for condensable particulate matter, this test program will be conducted using only Method 5. EPA did not include the OTM-18 (precursor to the current revision of Method 202) condensable particulate in the final CISWI rule. • Each Method 5 test run shall be a minimum of 1.75 hours long and will collect a minimum sample volume of 1.5 cubic meters. • Method 5 may be combined with Method 29 in a single sampling train.
HCl	Method 26A	• Each Method 26A test run will be a minimum of 1.5 hours long and will collect a minimum sample volume of 1.5 cubic meters. • Because Method 26A will be used only to quantify HCl, the two impingers with 0.1N NaOH (for halogen measurement) will not be included in the Method 26A sample train. •
Cd, Pb, & Hg	Method 29	• Each Method 29 test run will be a minimum of 1.75 hours long and will collect a minimum sample volume of 1 cubic meter per hour of sampling. • When short-duration Method 29 tests are run, longer Method 29 tests (4-5 hours) are to be run simultaneously. • Front half and back half metals will be analyzed and reported separately. • Only cadmium, lead and mercury will be analyzed in each Method 29 samples. • Method 5 may be combined with Method 29 in a single sample train.
CO_2& O_2	Method 3A	• EPA Method 3A will be used to determine CO_2 and O_2 concentrations. O_2 data is needed during all emissions testing periods to allow emissions corrections to 7% O_2.
Moisture	Method 4	• EPA Method 4 will be used to determine stack gas moisture content, as part of the isokinetic methods (Method 5, Method 26A, Method 29, and Method 23).

POLLUTANT	TEST METHOD	APPLICATION NOTES
Flow rate	Method 1 & 2	• EPA Method 1 shall be used to determine sample traverse points and stack sampling location. • Method 2 shall be used to measure volumetric stack flow rate, as part of the isokinetic methods (Method 5, Method 26A, Method 29, and Method 23).
Dioxin/Furan	Method 23	• Each Method 23 test run shall be a minimum of 4 hours long, and will collect a minimum sample volume of 2.5 cubic meters. • Method 23 requires the glassware in the sampling train to be rinsed with acetone and methylene chloride and then have a separate "quality assurance" rinse with toluene. The method mentions keeping the toluene rinse separate and analyzing it separately. For this test program, the laboratory may combine the toluene rinse with the methylene chloride/ acetone rinse to save the analytical cost of an additional sample fraction. The combining of the toluene rinse with the methylene chloride/acetone rinse for analysis is considered a minor change to a test method, and was specifically addressed in Guideline Document GD-051B on EPA's EMTIC website. • High resolution mass spectroscopy should be included as part of the Method 23 analysis. • No analysis of Method 23 audit samples will be performed, due to their unavailability and cost/logistics of a non-agency entity obtaining and analyzing audit samples in a remote location with a short testing lead time. • One XAD trap trip blank shall be analyzed per facility. • One field blank shall be collected and analyzed per site.
SO_2	Method 6C	• Suitable SO2 analyzer(s) operating range(s) will be used to obtain a minimum detection to 1 ppm, while still maintaining the ability to measure short term spike SO2 values up to 500 ppm. A dual range SO2 analyzer may be used if available.
NO_x	Method 7E	• It is envisioned that a single NOx analyzer operating range will be sufficient to cover the entire range of expected NOx emission concentrations.

POLLUTANT	TEST METHOD	APPLICATION NOTES
CO	Method 10	• Because incinerator CO concentrations may vary substantially during a test run, special considerations are needed for the Method 10 CO analyzer. The CO analyzer operating range(s) must be capable of detection down to 1 ppm, while still maintaining the ability to measure short term spike CO values up to 10,000 ppm. A dual range CO analyzer or two CO analyzers (a low range and a high range analyzer) likely will be needed to better assure that CO measurements do not exceed the analyzer operating range during any test run.

1.5 EMISSIONS TEST METHOD QA/QC

All method quality assurance requirements need to be strictly followed. Appropriate method blanks, reagent blanks, calibration checks, etc. specified in each test method need to be followed. No audit samples will be included in this test program due to their unavailability and cost/logistics of a non-agency entity obtaining and analyzing audit samples in a remote location with short testing lead times. All sample holding times and method shipping requirements also need to be followed. Glassware needs to be cleaned before use following the procedures in each test method. Sample recoveries and analysis times need to be conducted within the timeframe and procedures outlined in the test methods. Sample shipping methods need to be carefully selected to ensure that the laboratory receives the samples in a timely manner.

An important consideration in the testing QA/QC is an understanding of method detection and reporting limits associated with each test. For each test, the laboratory must report the method detection and reporting limit and show a calculation of how it was achieved. For many analytes, this may be accomplished by following the instructions for the specific EPA method in use.

If a test result is returned that is below the method detection limit, the laboratory should report the value at the level of the method detection limit for that analyte. If the value is above the method detection limit, but below the reporting limit, then the raw test result should be reported but flagged appropriately.

In the next two tables this protocol outlines detection or reporting limits that need to be targeted, by analyte, and provides further references for information on the methods in use and the detection limits. If a laboratory is able to meet a lower detection limit than those listed below, that would naturally be most welcome.

For the metals, hydrogen chloride, particulate matter, and dioxins and furans analytical detection limits are specified and listed in Table 4. Analytical detection limits are limits that must be met in the laboratory analysis. As the tests for these analytes involve sending samples collected in impingers or on filters to a laboratory and conducting analysis there, this form of the detection limit is the most natural choice for these analytes. The analytical detection limits may later be converted to in-stack detection limits using the volume of the liquid sample digested in the laboratory and the stack gas sampled according to Equation 29-1 in EPA Method 29 (see Table 4 footnotes for reference).

For sulfur dioxide, nitrogen oxides, and carbon monoxide, in-stack reporting limits are listed in Table 5. These are limits that need to be met for the exhaust gases coming out of the stack. As part of the gaseous analyte procedure involves challenging the instruments with a 1 ppm gas (see below), the limits for these analytes are specified as reporting limits, rather than detection limits, to insure we have the appropriate accuracy needed to measure the challenge gas accurately. As detection limits will never be greater than reporting limits, the detection limits for the instruments used will therefore be equal to or lower than 1 ppm. Since the concentrations of these analytes are measured by on-site instruments rather than through remote analysis, in-stack limits are the preferred choice.

Table 4. Summary of Needed Analytical Method Detection Limits for Metals, PM, HCl, and Dioxins, and References

ANALYTE	MEET OR EXCEED THIS LIMIT	REFERENCES
HCl	0.2 μg/mL	Method 26A guidance[2] Method 301 guidance[3]
PM	1 mg on filter	EPA Memo[4]
Cadmium	0.1 ng/mL	Method 29 guidance, Table 29-1[5] Method 301 guidance
Lead	1 ng/mL	Method 29 guidance, Table 29-1 Method 301 guidance
Mercury	0.2 ng/mL	Method 29 guidance, Table 29-1 Method 301 guidance
Dioxins/ Furans	10 pg/sample for tetra-dioxins/furans 50 pg/sample for penta-, hexa- and hepta-dioxins/furans 100pg/sample for OCDD and OCDF	Method 23[6]

For the metals, assurance is needed that the particular test used by a testing laboratory is able to meet or exceed the requested method detection limits. Method 29 guidance indicates that for mercury, cold vapor atomic absorption spectrometry is recommended to obtain the detection limit above. However, if a laboratory can achieve the detection limit through another method, that would be acceptable as long as the detection limit is met. Graphite furnace atomic absorption or ICP/MS analysis are recommended to achieve the detection limits above for lead and cadmium. AES or standard ICP should not be used.

Laboratories should follow the guidance in EPA Method 26A for hydrogen chloride.

For both Method 26A and Method 29 laboratories should determine the minimum detection level in the reagent/media matrix of the sampling and analytical method following the procedure defined in Section

[2] http://www.epa.gov/ttn/emc/promgate/m-26a.pdf, Section 13.3.
[3] http://www.epa.gov/ttn/emc/promgate/m-301.pdf, Section 15.0.
[4] EPA-HQ-OAR-2003-0119-2672 provides estimates of PM detection levels based on filter catch.
[5] http://www.epa.gov/ttn/emc/promgate/m-29.pdf
[6] http://www.epa.gov/ttn/emc/promgate/m-23.pdf

15.0 of Method 301. Laboratories should report the MDL, corrected for unique sample dilution factors, with each sample analysis. Laboratories, in detailed laboratory reports, should report both the MDL in the units of the applicable test method and the MDL in terms of final emissions results corrected for the sample volume and analysis dilutions in the units of the applicable emission standard.

Method 23 provides additional guidance on calculating the method detection limit for dioxins and furans. Laboratories should specifically note Equation 23-7 and the antecedent equations for guidance on obtaining the values of the parameters used therein. Laboratories should report the values of the parameters used in Equation 23-7 so that end users may understand how the detection limits were derived. Values below the method detection limits for each sub-analyte should be reported at the method detection limit for that sub-analyte. For the Method 23 tests high resolution mass spectroscopy should be used.

The PM method detection limit will depend on the volume sampled, but the typical catch detection limit in Table 4 is recommended based on a memorandum in the CISWI docket (see Table 4 footnotes for reference). Laboratories should meet this limit.

An EPA memorandum (see Table 5 footnotes) provides guidance on how to calculate detection limits for gaseous analytes. We emphasize that the limits presented in Table 5 are reporting limits; the detection limits will be equal to or lower than the reporting limits sought. However laboratories should still calculate the detection limits according to the procedure below, while insuring the requested reporting limits are met or exceeded.

Table 5. Summary of Needed Maximum Reporting Limits for Gaseous Analytes and References

ANALYTE	MEET OR EXCEED THIS LIMIT	REFERENCE
CO	1 ppm for low-span	EPA Memo on MDLs for gases[7]
SO_2	1 ppm for low-span	EPA Memo on MDLs for gases
NO_x	10.25 ppm (based on 250 ppm span)	EPA Memo on MDLs for gases

According to the referenced memorandum, the detection limits may be calculated as percentages of the span. EPA methods for the gaseous analytes provide maximum limits on the allowable calibration error (2 percent), interference (2.5 percent), calibration gas (2 percent), and drift (1.5 percent) requirement errors as a function of the span.

Knowledge of these limits allows the user to calculate the overall detection limit of the instrument, according to the EPA guidance. Following the second equation on page 2 of this memorandum, the highest allowable minimum detection limit MDL as a function of span S may be calculated as:

$$MDL = ((0.020 \times S)^2 + (0.025 \times S)^2 + (0.015 \times S)^2 + (0.020 \times S)^2)^{1/2}$$
$$MDL = 0.041 \times S$$

[7] EPA-HQ-OAR-2003-0119-2681 provides details on the calculation of minimum detection limits based on calibration error, interference error, calibration gas following the traceability protocol, and drift.

By way of example, to determine the span needed to obtain a method detection limit of 1 ppm using the maximum EPA-allowed errors, one simply needs to divide 1 ppm by 0.041 to obtain a span of 24.4 ppm.

The example above assumes that the instrument meets the highest allowable EPA limits for each of the error components. However, if the limits for a particular instrument are lower than the EPA-allowed errors, the MDL will be different. Therefore the limits will vary from instrument to instrument.

For example, if an instrument instead has a calibration error of 1.0 percent rather than 2.0 percent, following the MDL calculation will now yield

$$MDL = ((0.010 \times S)^2 + (0.025 \times S)^2 + (0.015 \times S)^2 + (0.020 \times S)^2)^{1/2}$$
$$MDL = 0.037 \times S$$

and in this case, to obtain a 1 ppm detection limit, a 27.0 ppm span may be used. Alternatively, the same 24.4 ppm span used above would result in a 0.90 ppm method detection level for this instrument. Again, it is emphasized that this is presented as an example, and that the method detection level for a particular instrument may be different, depending on the individual errors.

Particular care must be paid to CO and SO_2. As noted above, reporting limits at or below 1 ppm are necessary to capture accurately the low concentrations that may occur during the cycle. Dual-range or multiple analyzers will be needed to insure detection at low concentrations while also retaining the ability to measure high concentrations.

In order to test that concentrations at this level are being captured accurately, in addition to the method's specifications, the low-range analyzers should be challenged with a 1 ppm calibration gas after completion of each SO_2 and CO sampling run. Challenging the low-range SO_2 and CO analyzers in this manner will demonstrate the ability to accurately measure low concentrations of CO and SO_2.

NO_x concentrations recorded during the CISWI-ICR tests were higher, and our recommendation is to utilize a single calibration span, as one span can encompass all the results registered in the CISWI-ICR database. The order-1 ppm values frequently observed during the CISWI-ICR tests for CO and SO_2 were not observed for NO_x, so we do not believe the dual-range analyzer or the low-concentration calibration gas challenge is necessary for that analyte.

The discussion above focuses on the method detection limits required for the metals, and reporting and detection limits for the gaseous analytes. Both sets of limits for all analytes should be provided by each laboratory subcontracted under this protocol. If a sample returns a value above the detection limit but below the reporting limit, the value should be reported, but flagged, by the laboratory.

1.6 DISCUSSION

The goal to completely characterize the emission profile of incinerators tested could be at odds with sample volumes required of cadmium, lead, and mercury to meet detection limits. These detection limit concerns require that long, multi-hour test runs be conducted, possibly averaging out spikes or dips in the emission profile of these pollutants. This program is designed to ensure detection limits are met while also learning as much as practically possible about the higher-frequency variability in metals emissions by considering two different metals sample trains operating for two different periods.

Each method requires time between test runs to exchange test equipment and prepare for the next run. The example schedule has been designed to allow for a realistic window between test runs. This time should be kept to a minimum by the source testing contractors selected for each incinerator. Nevertheless, any emissions during these windows will not be captured.

2.0 WASTE FEED ANALYSIS

The purpose of the waste feed analysis is to evaluate the potential impact of waste feed variation on the emission test results. Specifically, the goal of the program is to understand the contents of the waste input to the burn chamber at the time any emissions spike(s) occur. By having this knowledge, we can understand the potential causes of unusual emissions results. This will be accomplished by a quantitative laboratory analysis of waste samples taken from each SRI site participating in Phase I activities.

2.1 PRE- TEST PREPARATION

Site- specific sampling and analysis plans (SAPs) should be developed prior to any testing, and must be tailored to the specifics of each facility and unit. Guidelines associated with these elements of the waste characterization are provided below. The SAP will describe the objectives and details of the individual tasks of the sampling and analysis and how they will be performed considering the waste factors listed above. The SAP should contain the following:

1. Specific sampling objective
2. Site description
3. Method of collecting the samples
    a. Appropriate equipment for acquisition of the samples
    b. Appropriate containers to hold the samples
4. Logistics for sampling
    a. Number of samples
    b. Sample size
    c. Collection frequency
    d. Number of personnel needed
    e. Exact site at which sampling will occur
5. Parameters to be analyzed
6. Analysis methods
7. Sample preparation
8. Packaging and shipping method
    a. Consider analytical requirements for sampling, preservation, and holding times
9. Quality assurance and quality control
    a. Consider preparation, maintenance, calibration, and cleaning of containers and equipment and chain-of-custody protocol
    b. Include precision and accuracy requirements

It is important to understand the conditions and procedures at each individual facility. To that end, a pre-sampling visit needs to be conducted at least 45 days prior to the start of sampling in order to learn more about the facility's procedures and address practical issues that will arise during the inspection program. These surveys will examine any unique site conditions that should be included in the respective site-specific SAP.

Topics to be confirmed and reviewed during the pre-sampling visit include:

- Quantifying the number of sub-sites that deliver waste to each unit
- The typical schedule of waste deliveries from each sub-site
- The typical operating schedule of each SRI
- Normal volumes of waste at a given facility
- The exact location(s) at which the waste sampling will occur
- The number of personnel to be needed for the protocol's waste sampling activities
- The equipment that will be needed at that particular site
- Procedures for handling sludge (if applicable)

- The amount of waste to be sampled (10 percent is recommended but facilities with unusually high throughputs may need to sample less, and facilities with unusually low throughputs more)

By performing the site visit at least 45 days in advance of the sampling, facilities should have ample time to assign personnel or order additional equipment if their review indicates additional assets are necessary.

If a particular SRI incinerates sludge, then the pre-inspection visit should review the sub-sites from which the sludge is sourced (i.e., does the sludge always come from one sub-site or is the source variable) as well as the handling of the sludge (i.e., is it dried or bagged before loading to the SRI). The answers will be used to inform the number of samples recommended to be taken during the inspection program.

Another important pre-sampling activity will be to obtain the tare weight of dumpsters or containers used to deliver loose, unbagged waste. The total weight of the waste to be charged will be measured as part of this protocol. Therefore, as part of the pre-sampling activities, the dumpsters or other containers to be used should be weighed while empty. The tare weight should then be affixed to the container itself (using a large, securely fastened label, for example) for easy reference during the waste inspection activities. Then, during the protocol activities itself, full dumpsters and barrels may be weighed, and the tare weight simply subtracted, to determine the net weight of the contents.

It will be the responsibility of the waste feed sampler to determine and procure the equipment and supplies necessary to complete objectives in any SAP developed for use with this protocol. A sample list of equipment appears below in Table 7, but facilities may find additional equipment not listed in the table will also be helpful.

The SAP should also recognize and adapt to the type of SRI charging used as sampling procedures will need to be sensitive to these differences. For a batch incinerator, where the waste is loaded once at the beginning of a burn cycle, it is anticipated that sampling the waste before charging will not present a problem. For semi-continuous units and continuous units, where smaller charges are added throughout the burn cycle, samplers must be able to sample waste quickly before it is charged.

Continuous units charge waste as soon as it arrives at the incinerator. These units will be especially demanding for the sampling of waste as typically the refuse is burned as soon as it arrives at the site. At semi-continuous units, waste is charged to the unit at regular intervals. The waste charge is not literally uninterrupted as it would be at a truly continuous unit, but neither is the totality of the waste to be incinerated loaded to the burn chamber at the beginning of the process as at a batch incinerator.

Continuous and semi-continuous units are expected to have more difficulties conducting the sampling given the limited time between the arrival of refuse on site and the incineration. In each case, good judgment should be used to tailor a SAP taking into account each individual facility's unique needs.

The best practice is to sample waste from each delivery to the SRI. If it is not possible because of time constraints to sample every delivery of waste, then as many deliveries as possible should be sampled. If the time available to sample is not sufficient to take a sample from every delivery to the SRI, then it is recommended to obtain a sample from each source (industrial, kitchen, office, etc.).

Below are some practices that units may wish to consider for their SAP. These will be especially important for continuous and semi-continuous units, where the time between arrival of waste and incineration is much more limited.

-Send waste to the SRI in small deliveries. If refuse arrives in small deliveries, it will be easier to sort the waste than if it arrives in larger deliveries.

-Perform some waste sorting at the sites where waste is generated (office, kitchen, remote industrial sites) so that each container delivered to the SRI from each site has similar contents. Using this method, bags arriving will have substantially similar contents, so that the method mentioned in Section 2.2.2 below of pulling 10 percent of individual bags rather than sorting through 10 percent of each bag could be used instead.
-Develop a system of coding such that it can immediately be ascertained from where the waste originated. For example, using color-coded trash bags or marking bags with identifiers such as "K" for kitchen, "I" for industrial site will allow samplers to know immediately the source of the waste. Similarly, if dumpsters or barrels are similarly marked it will also be very useful to samplers. Of course, if containers such as dumpsters are marked they should only be used to store and transport waste from the sub-sites indicated by the marking.
-Deliver waste once per day (the early morning, for example). Without continuing arrivals of waste at the site, it will be easier to conduct the sampling.

2.2 SAMPLING GUIDELINES

This section will detail how to collect a representative sample of the waste incinerated during the emissions test. A discussion will describe how to collect a sample representing the average properties of the waste, the quantity of samples required to represent the variability of the waste stream, and how to create composite and laboratory samples for offsite analysis.

This section will describe the process for sampling the waste stream. The specific procedures required to properly sample waste will vary due to site-specific conditions. This protocol will directly address several probable scenarios; however, each site should carefully consider the site specific conditions and tailor the procedure accordingly. It is stressed that facilities will need to adapt the guidelines offered here to their unique procedures and needs.

Before beginning the sampling, the total amount of waste received in each delivery should be weighed and recorded in the log, along with the date and time. For the incinerator operations monitoring, it is also necessary to record the weight of the waste in each batch or each charge (for a semi-continuous unit). This could be accomplished by assigning each bag, dumpster, barrel, or piece of loose waste a unique tracking number and noting the unique tracking number along with the date, time, and weight of each unit. The tracking number must then be affixed to the bag, article, or unit. The person feeding the incinerator then notes the tracking numbers in a second log as the waste is charged to the unit. By this method the amount of waste in each batch/charge may be determined by matching the tracking numbers in the second log to the weights in the weigher's log. Alternatively, each piece could be weighed a second time and the date, time, and batch/charge assignment recorded just before being fed to the unit.

There are two sections below. In the first section, general guidelines for the waste sampling are discussed and examples are discussed. However these are only examples and facilities will need to modify the suggested procedures here to their particular practices and conditions. The second section discusses practical issues and offers suggestions for addressing them. Figure 1 follows the discussions and illustrates the sampling process. The sample collection procedure includes multiple steps to reduce the sample and produce a sample representative of the whole waste stream which is of appropriate size for shipment and analysis at an offsite laboratory. To simplify discussion, the nomenclature contained within this section is as follows:

Waste: The totality of the waste which is to be incinerated during the emissions test.
Sample: The initial sample collected, equal to 10% of the waste, sorted by category.
Composite sample: First reduction of the sample, representative of 10% of the sample, proportioned by category and well mixed.

Composite subsample: Second sample reduction, equal to 40% by weight of the composite sample, ground and mixed well.
Laboratory Sample: Sample meeting the requirements of the laboratory for volume/mass and sent offsite for analysis.

2.2.1 GENERAL WASTE SAMPLING GUIDELINES

The goal of the waste sampling is to produce a sample that is representative as possible of the entire waste incinerated at the site. The sample should reflect the source composition of waste at a particular site; that is to say, if 60 percent of the waste at a site is produced by the kitchen, 20 percent by offices, and 20 percent by industrial activities, then the sample should reflect the same 60/20/20 proportion of waste by sources. Ideally all waste generated should be sampled. But if it is impractical to sample all the waste, the material selected for sampling should preserve the relative proportions of waste generated by each sub-site.

The sampling of each delivery of material brought for incineration must also be random. That is, a portion of the waste should be drawn by chance for sampling rather than continually picking waste with a particular attribute (for example, waste on top of a dumpster or trash can). Random sampling greatly reduces the chance that particular types of waste are missed in the sampling and insures as far as possible that the samples taken will be representative of the total waste at the site.

If sludge is incinerated at a particular unit, it should not be comingled with the rest of the waste in the sampling process below but handled separately instead. Further information on sludge handling appears in Section 2.2.3 below.

The guidelines below are drafted with these goals in mind – that the waste sampled is representative of the source composition at the site, and the individual samples are taken at random. A series of steps for a sample waste sampling plan are presented below. Please note that the steps below are guidelines and not exact procedures to be followed. Facilities are expected to modify the exact procedures based on their unique needs but should do so in a way that insures the sample is random and representative.

Step 1: Sample collection
A randomly selected sample equal to 10 percent by volume or weight (whichever is most practical) of the total waste to be incinerated should be collected. The exact technique for this will depend on the manner in which waste is handled at each facility. Also, the recommended 10 percent sampling ratio should be reviewed in the pre-sampling work and may be adjusted upward or downward, depending on the volume of waste handled at the facility (facilities with very high volumes may sample less while facilities with unusually low volumes may sample more). Four example scenarios of waste to be sampled are discussed below. Then, following the scenarios, information pertinent to all of the examples is discussed.

Example A: High-capacity batch incincerator
The first example is of a high-capacity, batch incinerator where a number of dumpsters are staged at the incinerator before start-up. This example is also relevant to continuous or semi-continuous units where a large amount of waste is staged overnight or delivered. These sites should sample the waste staged overnight in the early morning, before the incinerator is activated for the day, according to these guidelines.

In this example, it will be useful to group dumpsters known to have substantially similar contents. For example, if the same industrial site delivered two dumpsters full of waste, the kitchen delivered two dumpsters full of waste, and the office delivered one dumpster full of waste, and it is not possible to sample all five dumpsters, then it will be easiest to sample only one of the two dumpsters from the industrial site and only one of the two

dumpsters from the kitchen, as well as the office dumpster. However, in order to preserve the proportions of waste in the overall population, the samples from the one kitchen and one industrial dumpster delivered should be twice as large as the sample taken from the office dumpster.

In order to begin the sampling, take 10 percent of the waste from the office dumpster, and 20 percent of the waste from one of the two dumpsters with kitchen waste, and 20 percent from one of the two dumpsters with industrial waste. Of course, sites could take 10 percent from each of the five dumpsters, but if time is limited only one dumpster from each sub-site may be sampled, such that the overall proportion of waste from each sub-site is preserved.

In order to sample the dumpsters, for each dumpster that is to be sampled, the units may be tipped over by heavy equipment. If the dumpsters contain both bagged and loose material, then the waste drawn from each dumpster for further sampling should also consist of both bagged and loose material. Once individual parcels of waste are taken from each dumpster to be sampled, the waste may be co-mingled into one larger sample and sorting conducted on this combined sample. The contents of this co-mingled sample should be sorted and placed on a gridded tarp with roughly the same amount of material placed on each grid cell (see details below). A number of the grid cells, sufficient to compose the necessary percentage of material to be sampled out of that dumpster, are then chosen at random to reconstitute a sample. That is to say, if 10 percent is required from the dumpster and 30 grid cells are on the tarp, then three should be chosen for sampling. If 20 percent are required, then 6 of 30 should be chosen.

If it is impractical to tip the dumpster a backhoe could be used to sample the contents. If that is not available, personnel standing on ladders and armed with implements such as augers or shovels, could sample the dumspters manually. Sites using this method will need to check in the pre-site activities that their ladders are tall enough and augers long enough, to accomplish this goal. If the dumpster is not physically tipped over and emptied, is it crucial to sample from different depths of the dumpster; that is, to pick some waste from the top of the dumpster, some from the middle, and some from the bottom. This eliminates the problem of stratification of waste in the dumpster.

The time, date, and sample drawn (10 percent from each of five dumpsters, or 20 percent from one of two industrial waste dumpsters, 20 percent from one of two kitchen waste dumpsters, and 10 percent from the office dumpster) should be recorded in the log book.

Example B: Continuous-feed incinerator with dumpsters arriving throughout the day

If a large amount of waste is staged overnight, it should be sampled as in Example A above. The remainder of this sub-section discusses the sampling of arrivals of waste occurring throughout the day.

If possible, each dumpster may be tipped and the loose contents and bagged contents spread on a gridded tarp, and a number of grid cells drawn such that 10 percent of each are taken to reconstitute the sample. If tipping the dumpster is not possible, the contents may be sampled while in the dumpster as in Example A above, but facilities using this procedure should be careful to sample material from the top, middle, and bottom of the dumpster. As in Example A, the date, time, and number and percentage of dumpsters sampled (or not sampled) should be recorded in the log book.

Example C: Batch feed, small delivery

In this example, a small delivery of trash bags are delivered to a batch feed incinerator. It is likely that a larger amount of refuse will be delivered overnight or in the early morning for combustion in a morning batch, in which case the unit should refer to Example A for instructions on how to sample that batch. If additional refuse arrives later in the day, for incineration in a second daily batch, the guidelines below should be followed.

For this example, bags may first be grouped into sub-populations whose contents are known to be substantially similar (waste delivered from the same sub-site, at the same time). In this case, not every bag need be sampled if it is known that other bags that have substantially similar contents will be sampled. For example, say that a batch containing 10 bags from the kitchen, 5 bags from an office site, and 5 bags from an industrial site constitute the sample. If the kitchen bags all have similar contents, the office bags all have similar contents, and the industrial bags all have similar contents, then only one bag from each site need be sampled. In order to obtain a 10 percent sample in this example, one bag from the kitchen, one-half of an office bag, and one-half of an industrial site bag should be taken. This should only be done if bags are known to be substantially similar; if there is doubt then each bag should be sampled.

Alternatively, each bag could be opened and spread on the gridded tarp and cells chosen at random such that 10 percent of the contents are taken to reconstitute the sample. However if sites are limited on time the alternate sampling in the paragraph above is offered instead.

The date, time, and manner of sampling (percent of bags sampled, whether some bags were not sampled) should be noted in the log book.

Example D: Small-capacity, semi-continuous feed incinerator with bags delivered throughout the day

In this example, a series of small, 13-gallon trash bags are brought to the SRI site for immediate incineration, with no set schedule.

Ideally, each bag would be opened, the contents spread on the gridded tarp, and enough cells chosen at random such that 10 percent of the contents are taken and reconstituted to be the sample from that bag.

If that is not possible, foreknowledge of the source of the waste material may be used. For example, if 10 bags arrive from the same source and are known to have substantially similar contents, then one bag may be taken as the sample. As with the other examples, and all sampling activity, the date, time, and procedure used to choose the sample (sampling each bag, or only choosing 10 percent of similarly-sourced bags) should be written in the log book.

Sampling Guidelines Pertinent to All Sites

One of the goals of the sampling program is to achieve a random sample in such a way as way to eliminate human bias from the selection process. The best way to achieve this is to apply a grid which divides the waste to be sampled into a grid with more than 10 spaces, for example a 30-space (3x10) grid. The waste is spread on this grid with approximately equal portions of the waste belonging to each grid cell. Then, using a random number generator, numbers are drawn such that 10 percent of the grid blocks are chosen, and the waste from those blocks is included in the sample. For a 30-space grid, each grid block is assigned a number from 1 through 30, and a random number generator (such as one on a computer or smart phone) is used to draw three numbers between one and 30. The waste belonging to these three grid blocks will then constitute the sample for further analysis.

Precautions should be taken to prevent contaminating the samples destined for quantitative analysis in a laboratory. Samplers should only touch the sample while wearing disposable latex or nitrile type laboratory gloves; sample containers, bags, buckets, etc should be rinsed with a residue free detergent, such as Alconox, before and between contact with any sample. Visqueen plastic sheeting used to sort or store samples should also be decontaminated with residue free detergent before use. Distilled water should be used to rinse the equipment.

Step 2: Sorting the sample

Each of the selected samples must be sorted into 10 categories:

- Paper
- Cardboard
- Compostables (kitchen/food waste)
- Textiles
- Plastics
- Glass
- Metals
- Electrical equipment
- Fines
- Other (waste which doesn't fit into the rest of the categories)

In order to separate the fines from the other categories of waste, the waste should be sifted through a grate. A grate may be constructed using ½" chicken wire and split wood 2x4s. Place the sample waste in the grate and sift over a Visqueen sheet. The fines will fall through the bottom of the grate, while items from the other nine categories will remain above the grate. The material which is too large to fall through the grate may then be sorted into its nine categories. Then, using a dustpan and brush or squeegee, the fines which fell onto the Visqueen sheet are swept up and placed into the fines bin or bag. For each subcategory of waste, a total weight of the sample and each category must be measured. A data sheet should be prepared beforehand to tally and log each category's weight and the initial volume or weight of the sample.

If the sample is large, as in the case of the high capacity incinerator discussed above, then it will be necessary to sort in stages, on separate sheets of Visqueen, using multiple weighings to calculate a total weight for each category. Once the sample has been completely sorted it should be placed into sample storage containers of sufficient volume for the task, i.e. 33 gallon trash cans or bags, 5 gallon buckets, etc , and labelled with the category it contains, the weight of the waste in that bag, a unique sample identifier, and the name of the sampler responsible for handling the container. This data should also be recorded onto into the logbook in a clearly understandable manner.

When sorting, it may not be practical to include all items found in the sample. Large inert items, such as sheets of glass, large pieces of metal should not be included due to the impracticality of reducing the size of these items. Batteries should also not be included in the sample, if found. All items which are sorted but not included in the sample should be noted on in the log book, information that should be collected is: type of material, weight, delivery of waste it was sampled from, and count (where appropriate).

Step 3: Preparing a composite sample

A composite sample should be selected that is equal to 10 percent of the total weight of each category. The selection of the contribution to the composite sample should follow the same random sampling procedure discussed in Step 1. That is to say, for each category, spread the contents on the gridded sorting tarp, and choose enough grid cells at random such that 10 percent of the individual category's material is selected. The final composite sample should not be segregated by category and should have the same proportions, 10 percent by mass, as the original sample. If the composite sample is too large to fit in one sample container then it should be mixed in such a way that each sample container contains a homogenous, representative portion of the sample.

Step 4: Selecting a composite subsample

The composite sample must be split into a smaller subsample that represents 40 percent by weight of the composite sample. The contents of the subsample should be made small enough that the entire contents of the subsample can be well mixed. This may involve breaking down the size of larger components of the sample, such as whole newspapers, larger wood scraps, large pieces of scrap metal, etc into smaller portions. This can be accomplished by using a field grinder, striking with a sledge hammer, or using a hammer mill. Some large samples can easily be reduced by hand, for example a newspaper can be shredded by hand or soft plastic can be cut into smaller parts with scissors. Some laboratories have the capability of doing the grinding in-

house, so facilities should check with the requirements of the contracted laboratory. If the laboratory can perform these services facilities may not need to perform this reduction in the field, but if a facility chooses a laboratory that cannot perform this reduction, then the facility will need to do the grinding themselves. Once the larger portions are reduced the entire subsample should be mixed to become a homogenous representation of the composite sample from Step 3.

Step 5: Selecting a laboratory sample

A representative, well mixed sample of appropriate size for shipment and analysis at a laboratory must be collected from the composite subsample. An appropriate sample is generally about the volume of a five gallon bucket; although the specific laboratory conducting the analysis should be consulted to determine if this volume meets their needs. This process will be similar to earlier sample reductions. If the subsample is stored in multiple containers, divide the weight of sample needed for the laboratory analysis by the number of containers. Select this amount from each container for inclusion in the final laboratory sample. Whether the composite sample is in one container or multiple containers, the contributions to the final laboratory sample should be selected in a random manner to ensure the final sample is representative of the original sample. This can be accomplished by spreading the composite subsamples out on a decontaminated sheet of Visqueen and randomly selecting portions until the proper amount is collected.

Step 6: Shipping the sample

An analytical laboratory should be selected in advance of the sampling event. The laboratory should be consulted prior to sampling for recommendations on sample containers, chain of custody (CoC) forms, shipping instructions, and minimum sample volume and mass needed for each analysis. Chain of custody forms should be completed and included with the samples sent to the laboratory. The CoC forms should include the sample unique identifiers, date and time of collection, laboratory analysis to be performed, names of the samplers, and any special instructions for the laboratory such as expedited sample analysis requests, reporting requirements, etc. Samples should be sent to the laboratory as soon as reasonably possible. In remote parts of Alaska this will involve working with client's logistics departments to determine the best method of shipment. All sample preservation instructions from the laboratory should be followed exactly. This may include shipping the sample in a cooler with frozen icepacks to maintain proper temperature requirements. In general, sample consisting of waste other than sludge can be sent with no ice packs for refrigeration. Samples which include sewage sludge should be sent with ice packs for refrigeration.

Reporting

Each sampling and sorting activity should be recorded in a log book. The log book entries will document the raw waste composition and aid in comparisons across incinerators, as well as serving as a record of activities at each individual site. An example log book entry is shown below in table 6.

Table 6. Log Book Entry Example for Sample Selection and Sorting

Date	July 28
Start Time	6:15 a.m.
End Time	7:00 a.m.
Location	XYZ Unit, Next to Incinerator
Sample ID	XYZ00122A
Containers Sampled	One dumpster from industrial outsite, one dumpster from kitchen
Containers Not Sampled	One dumpster from industrial outside

General description	Two dumpsters delivered from industrial outside and one dumpster from kitchen at unit in early morning. Dumpsters from industrial outside have similar contents, so only one sampled. 20 percent of bags/loose materials from one industrial dumpster and 10 percent of material from kitchen dumpster selected using shovels/augers by personnel standing on ladders. Industrial material included mainly packaging debris and metal scrap. Kitchen waste was mainly food scraps and some platic sheeting/aluminum foil. Waste material then sifted/sorted into 10 categories and composite sample taken.
Weight of Composite Sample	6.75 kg
Responsible Party	Joe Smith
Sorted Material Not Included in Sample	Four AAA batteries, one metal disk weighing 10 kg from industrial outsite dumpster
Other Notes	

Equipment for collecting a waste sample

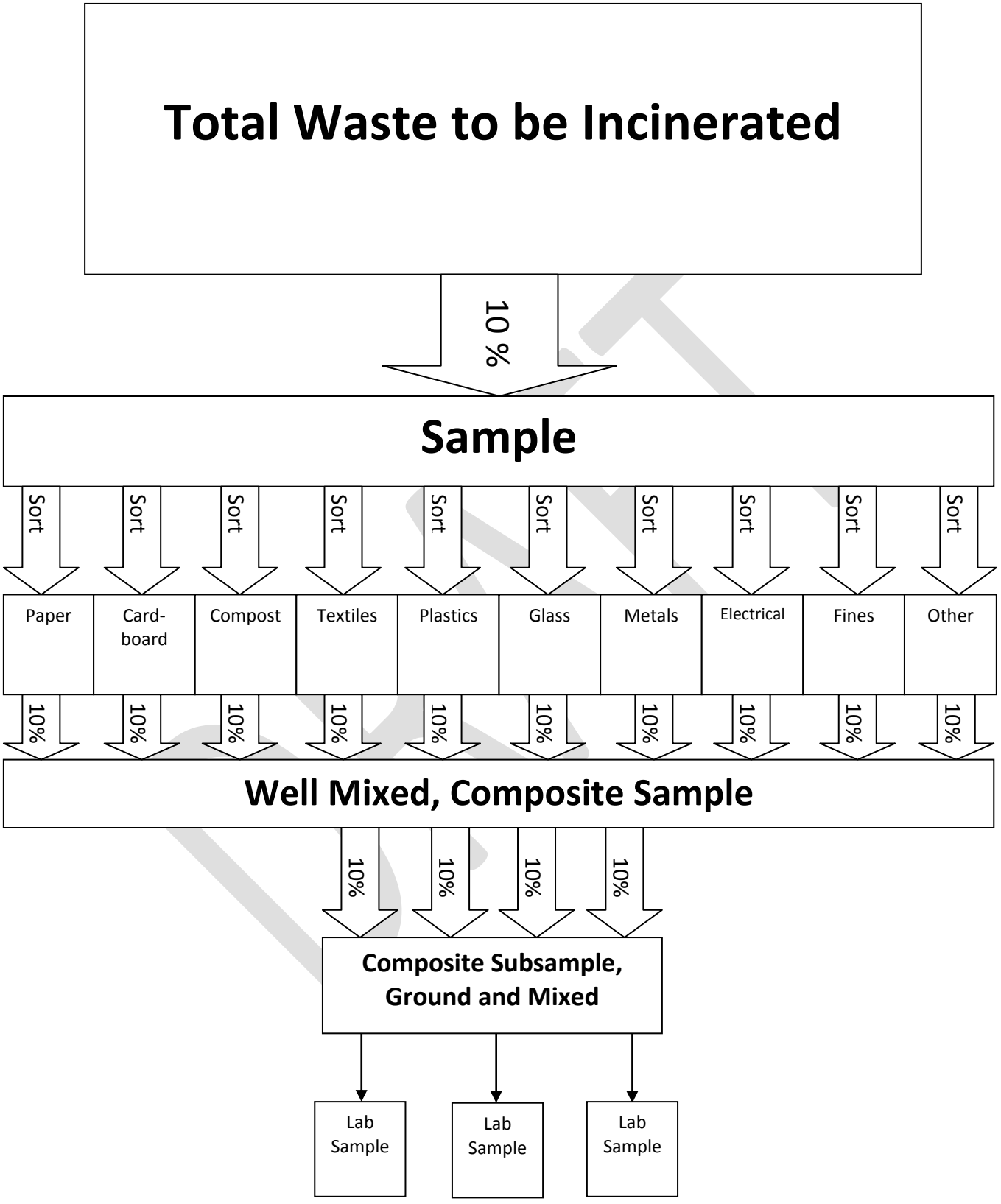
Table 7 lists the equipment required for collecting a sample of waste and provides some notes on the equipment usage.

Table 7. Waste Sampling Equipment

EQUIPMENT	USAGE NOTES
Scales	For weighing the total waste as well as the sample weights. A permanent onsite scale for weighing incinerator waste may be used, if available and appropriate. Should include primary and backup units.
Sledge hammer, scissors, knife	For reducing large components of waste material into smaller portions.
Visqueen	Plastic sheeting between 4 and 10 mils thick used for sorting the samples on.
Backhoe	For extracting samples from large containers (dumpsters).
A-frame ladder or step stool	For sampling from tall containers (dumpsters).
Chicken Wire and 2x4s	For use in assembling a grate
Dustpan/Squegee	For collecting the fines that fall through the grate
Shovels/Augers	For extracting samples.
Containers	32 gallon trash cans, 5 gallon buckets, roll of 39 gallon trash bags.
Camera	For documenting the samples.
Measuring tape	For assistance in determining waste volume.
Log book	For documenting the samples and activities.
Random number generator	e.g., http://www.random.org/

PPE	Requirements of the site plus sturdy work gloves, boots, safety glasses or goggles and hardhat.
Laboratory Gloves	Disposal laboratory, i.e. latex or nitrile, gloves to prevent sample contamination.
Residue free detergent	e.g., Alconox, for decontaminating sampling equipment.
Distilled water	For rinsing containers/equipment after cleaning
Laboratory containers	Clean containers for shipping the samples, supplied or recommended by the laboratory. Usually 5 gallon buckets with lids.
Shipping containers /boxes /coolers	5 gallon buckets with lids for shipping the samples via USPS, UPS, FedEx, etc.

Figure 1. Waste Sampling Flow Diagram



2.2.2 SUGGESTIONS FOR IMPROVING SPEED OF SAMPLING

Ideally, samples would be taken from every delivery of waste brought to the site. However, the volume of waste, the time between delivery and incineration, and the lack of available equipment are all factors which will impact the execution of the sampling.

In the four example scenarios above, some practical suggestions for sampling are discussed to allow sites to preserve the ability to obtain random and representative samples, if the ideal of sampling each delivery of waste cannot be met. Here several additional suggestions are highlighted to help sites address the practical issues regarding sampling. Some have been mentioned in the scenarios above, but are repeated for emphasis.

Pre-sorting at waste generation sites:
If it is known that a particular site is going to deliver, say, cardboard, plastic waste, and metals in a particular delivery, then each category of waste could be put in separate containers. Then, when the waste arrives at the sorting location, since the waste is already pre-sorted, the sampler merely needs to pull the same percentage portion from each bag or container to obtain a sample, rather than sorting through different types of waste that have been mixed together.

Foreknowledge of the source of waste:
If samplers are able to ascertain immediately the source of waste, they might be able to reduce the numbers of samples needed or be able to take samples more quickly (for example, pulling one of ten similar bags as a sample rather than opening each bag and taking 10 percent from each). Facilities may wish to develop a coding system to aid in this. For example, if kitchen waste always comes in yellow trash bags, and no other type of waste uses that color of bag, the contents of a bag arriving at the sorting site may be easily ascertained. Or, dumpsters could have markings such as “K” for kitchen, “I” for industrial, etc. so samplers can easily identify the source.

Taking individual bags for sampling rather than a small portion of each bag:
If a number of bags arrive and the contents are known to be substantially similar, rather than opening all bags, individual bags could be pulled aside for sampling. For example, if 15 bags from the office arrive simultaneously, in order to obtain a 10 percent sample, sites may simply pull one full bag aside and take half the contents of a second bag. This should only be done if the contents of the bags are known to be substantially similar, and that condition should be confirmed with the manager or supervisor of the individual sub-site producing the waste.

Issues and suggestions regarding larger containers
Larger containers such as dumpsters or large barrels are obviously more difficult to sample versus bags. Ideally, the contents would be emptied, spread across a grid, and sampled according to the guidelines in Section 2.2.1 above. If that is not practically possible some alternate methods for sampling from large containers are presented below.

A pre-delivery survey of the dumpster’s contents could be helpful to reducing the risk of missing unusual waste. By conducting a quick desk-top survey of the contents of the dumpster upon loading, and comparing to what is visible at the top of the dumpster at delivery to the site, it can be assessed whether a sample from the top of a deep container would be sufficient to capture the variability from the whole container. Of course, if the material at the top is not representative or the general contents of the dumpster are unknown, then this technique should not be used.

As recommended above, if the dumpster cannot be tipped, equipment could be used to help sample from the bottom of the dumpster. A backhoe, if available, would be ideal to reach into the bottom of the dumpster, but for a small dumpster a sampler standing on an A-frame ladder or step stool using a long shovel or auger could also be sufficient. For example, if it is decided to choose six bags of waste from a dumpster as a sample, then two of those bags should come from the top of the dumpster, two from a middle layer, and two from the bottom layer. As always, the sampling activity and method should be logged, along with a measurement of the total weight of waste in the dumpster (or an estimate thereof if a formal measurement is impractical).

2.2.3 SLUDGE SAMPLING

If a particular SRI disposes of sludge through incineration, then the sludge should not be commingled and sorted with the other waste but handled separately. SRIs not combusting sludge may disregard this sub-section.

If a facility only incinerates sludge on certain day(s) of the week, then a testing schedule should be chosen to insure that the sludge may be sampled and included in the waste charges.

Facilities should take samples of sludge for laboratory analysis of their contents. The number of samples to be taken depends on the number of different source(s) of sludge that a unit receives. For example, units might receive domestic sanitary waste, wastewater, kitchen sludge waste, sludge from industrial waste, or sludge from other sources. A minimum of three samples per source characteristic should be taken. That is to say, if 100 percent of the sludge incinerated at a unit is from domestic sanitary waste with no other sources of sludge present, then three (or more) samples should be taken. But if a unit burns both domestic sanitary waste and sludge from industrial waste, then three (or more) samples of each type (for at least six samples total) should be taken.

The samples should be taken wherever the sludge is pressed or dewatered into a more solid form. The output of this dewatering process is cakes or pellets of sludge. It is recommended that whole cakes, pellets, or whatever form the dewatered sludge takes be used for sampling. This avoids the problem of having to break down the cakes for further sampling, keeping handling of the sludge to a minimum while also insuring material from both the exterior and the interior of the cakes is included in the sample. The number of cakes or pellets to be included as the sample will be a number sufficient to match the laboratory's requirements for sample volume.

Facilities must be careful to avoid cross-contamination of samples. A phosphorus-free detergent such as Alconox should be used to clean any equipment, and washed equipment should be rinsed with distilled water.

Facilities should check with the laboratories they have chosen to perform the waste analysis to see if the contracting laboratory has any special requirements on the shipment of sludge (for example, whether maintaining the sample at a certain temperature is necessary, or if certain types of containers are required). The samples may then be shipped according to the requirements of the laboratory performing the analysis.

The date and time of sampling, total weight of the sludge delivered, sample ID, and person responsible for the sampling should be reported in the log book. An example entry for sludge sampling is shown in Table 8. Chain of custody forms should also be used to track shipments of the sludge samples.

Table 8. Log Book Entry Example for Sample Selection and Sorting

Date	August 4

Time of Sampling	4:00 p.m.
Corporation	ABC Energy Company
Unit and Location	Caribou Point Incinerator, Sludge Press in Incinerator Building
Sample ID	ABCCaribouSludge001
Source of Sludge	Sanitary Waste from dormitories
General description	Four dewatered, pressed sludge cakes are taken as a sample. Cakes are placed in a plastic tub as requested by laboratory and shipped by courier service.
Weight of Composite Sample	5.00 kg
Responsible Party	Joe Smith
Other Notes	Sludge will be included in the next batch to be charged to SRI, which will be tomorrow morning.

2.3 WASTE ANALYSIS GUIDELINES

The parameters requiring measurement and the analytical methods are provided in the table below.

Table 9: Waste Parameters

PARAMETER	METHOD
Waste weight	Measure sample weight
Waste composition, % by weight	Segregate and weigh each category of waste
Size	Visual analysis of major items as part of sample composition analysis
Density	Measure sample weight in known volume
Heating Value (gross/net)	Laboratory ASTM D240
Moisture, by weight	Laboratory D3173
Chlorine, by weight	Laboratory SW 9056
Sulfur, by weight	Laboratory D4239 or SW 9056
Nitrogen, by weight	Laboratory SM 4500-N D
Cadmium, by weight	Laboratory EPA 6010 or SW 6020B
Lead, by weight	Laboratory EPA 6010 or SW 6020B
Mercury, by weight	Laboratory SW 7471 or SW 7470

2.4 DISCUSSION

The preparation, sampling, and analysis outlined above are designed to provide an understanding of both the characteristics of the waste sampled and the handling procedures in place at each unit. However, given the finite nature of the proposed testing and sampling some level of uncertainty will persist. Events contributing to uncertainty include short term disposal events that occur between scheduled sampling (e.g. waste being generated as part of a short term construction or demolition project), as well as seasonal events that occur outside the proposed sampling period (sampling is only proposed during the summer months).

Unique events which generate unusual waste in any season may impact emissions, but will not be observed in this program unless they occur during the testing and sampling. Further, if waste handling changes from season

to season (for example, different procedures are followed during winter to minimize outdoor exposure time), these changes could potentially impact emissions as well.

It is reasonable to assume that as more activity occurs during summer, the most varied waste streams will be observed during this season. Additionally, as that is the season most conducive to heavy construction work, it is expected that the best chance of capturing periodic construction waste will be during the summer season.

Collection of quality data based on the waste stream analysis depends on control of the waste stream itself. "Fugitive" waste, of which the operators are unaware, may impact test results if it is present in the waste stream. As a result, diligent policing of the waste stream is required. The waste stream should contain no prohibited items or items that by policy are destined for other disposition (recycling, transfer off site). If these items are present and not accurately reported, confidence in the conclusions may be questioned. Operational changes from day to day and from season to season may also impact test results and need to be accurately documented as well.

3.0 AUXILIARY FUEL TESTING

An analysis of the auxiliary fuel used in each unit should also be conducted. It is likely that most units already conduct this analysis for other reasons, so units may already have this information available. If a unit does not perform auxiliary fuel testing, or if the tests previously conducted do not include results for all the parameters below, then units should conduct additional tests. Additionally, if SRI have not conducted a fuel test within 30 days of the testing under this protocol, or if the source of fuel has changed since the last auxiliary fuel test, then a new auxiliary fuel test should be conducted.

The auxiliary fuel tests should include analysis of the energy density, a proximate analysis, and an ultimate analysis, especially for sulfur and nitrogen content. The goal of the latter is to help in understanding of SO_2 and NO_x emissions at each SRI. There are a number of ASTM tests that will identify nitrogen or sulfur content and this protocol does not have a preference for any of those particular tests.

According to the desktop survey results, the auxiliary fuels used at the SRI fall into two categories: liquid, petroleum fuels (diesel or #2 fuel oil) and gaseous fuels (natural gas and propane). For each of the two cases, the auxiliary fuel should be sampled and shipped to a laboratory for analysis. The tests performed at the laboratory will depend on the type of fuel.

For facilities using liquid auxiliary fuels such as diesel or #2 fuel oil, the following tests should be conducted.

Table 10. Fuel Analysis Tests for Units Using Diesel or #2 Fuel Oil

ANALYSIS TO BE PERFORMED	TEST METHOD
Energy content, BTUs per unit volume or mass	Laboratory ASTM D240
Moisture (% fuel)	Laboratory ASTM D95
Ash (% dry fuel)	Laboratory ASTM D482
Cetane Number (Volatility)	Laboratory ASTM D613
Nitrogen content	Laboratory ASTM D5291 or similar
Sulfur content	Laboratory ASTM D4294 or similar

For facilities using gaseous fuels such as natural gas or propane, the following tests should be conducted.

Table 11. Fuel Analysis Tests for Units Using Propane or Natural Gas

ANALYSIS TO BE PERFORMED	TEST METHOD

Energy content per unit of gas	Laboratory ASTM D3588
Water vapor content	Laboratory ASTM D1142 or D5454
Composition (for nitrogen content)	Laboratory ASTM D1945
Sulfur Content	Laboratory ASTM D5504 or similar

In all cases, each SRI should check with the shipping company and contracted laboratory for any specific procedures needed regarding the shipment of fuel samples.

4.0 INCINERATOR OPERATIONS MONITORING

The incinerator monitoring information detailed below is necessary for understanding the difference(s) between incinerators or subgroups of incinerators and whether they have a material impact on test results. Operations monitoring will also enhance understanding of anomalous readings that may occur during a malfunction. Examining the incinerators' operational parameters at times of high test results may provide additional clues in understanding highly variable results.

This section details the process parameter data to be collected, the frequency of the data collection, and the party responsible for collecting the data. The recommended data collection methods and calibration procedures are also listed. Reporting of calibration results is not necessary but it is critical that the operational parameters listed below be included in the report discussed in section 4.0.

4.1 IDENTIFICATION OF PARAMETERS

The following is the list of operating parameters that are recommended for collection.

1. Waste Feed Rate
2. Combustion Chambers Temperature (primary and secondary)
3. Combustion Chambers Pressure (primary and secondary) if available
4. Auxiliary Fuel Feed Rate

4.2 OPERATIONAL DATA COLLECTION

The table below identifies the process parameter data to be collected and the frequency of data collection. An Incinerator Monitor should be identified at each site who is responsible for collecting the indicated data throughout the duration testing and sampling.

Table 12: Incinerator Monitoring and Responsibilities

OPERATING PARAMETERS	FREQUENCY OF DATA COLLECTION	PARTY RESPONSIBLE
Waste Feed Rate	Continuous Burn: Hourly Batch Burn: At Charge	Local facility
Combustion Chambers Temperature	Continuous during sampling	Local facility
Combustion Chambers Pressure	Continuous during sampling, if available	Local facility
Auxiliary Fuel – Feed Rate	Continuous during sampling	Local facility

4.3 METHODS FOR COLLECTING INCINERATOR OPERATIONS DATA

The table below provides (1) monitoring methods, (2) monitoring equipment, (3) monitoring location, and (4) typical methods of data recording.

Table 13: Incinerator Operations Monitoring Methods

PARAMETERS	MONITORING METHOD	MONITORING EQUIPMENT	MONITORING LOCATION	METHOD OF DATA RECORDING
Waste Feed Rate	Weight Measurement	Scale	Waste Staging Area	Written Record
Combustion Chambers Temperature	Not Applicable	Thermocouple	Primary Chamber Exit, Secondary Chamber Exit	Data Logger/Manual recording
Combustion Chambers Pressure, if available	Not Applicable	Differential Pressure Gauge	Primary Chamber Exit, Secondary Chamber Exit	Data Logger/Manual Recording
Auxiliary Fuel – Feed Rate	Not Applicable	Flowmeter	Burner Inlet(s)	DCS/Manual Recording

4.4 PROCEDURES AND METHODS FOR INCINERATOR OPERATION MONITERING QUALITY ASSURANCE

The quality assurance procedures are outlined below. These are recommendations and not required reporting elements.

1. All measurement devices that will be used to measure the operating data should be calibrated prior to the emissions sampling date using the procedure specified below.
2. All calibration should be performed according to the manufacturer's recommendation procedures or an appropriate industry consensus standard.
3. Except as described in Table 14, all measurement devices should be calibrated to an accuracy of 5%.
4. If units are able to conduct gaseous auxiliary fuel metering, the metering must either be pressure and temperature compensated metering, or a unique fuel temperature and pressure will be required along with each fuel meter increment recorded.
5. Auxiliary fuel metering readings must be recorded concurrent with the start and stop of each test run.

Table 14: Incinerator Monitoring Calibration Procedures

PARAMETER MEASURED	MONITORING EQUIPMENT	CALIBRATION METHOD	ACCURACY OF MONITORING EQUIPMENT	TECHNICAL BASIS FOR THE ACCURACY DETERMINATION
Waste Feed Rate	Scale	Known weight	± 2%	Repeated Calibration
Combustion Chambers Temperature	Thermocouple	Manufacturer Certification	± 0.5 ^{o}F	Laboratory Calibration
Combustion Chambers Pressure	Differential Pressure Gauge	Known Weight of Water	± 2% or manufacturer specification	Repeated Calibration
Auxiliary Fuel – Feed Rate	Flowmeter	Calibrated Meter	± 2% or manufacturer specification	Laboratory Calibration (See Also Section 4.4, Point 4)

The auxiliary fuel metering must either be pressure and temperature compensated metering, or a unique fuel temperature and pressure will be required along with each fuel meter increment recorded. The temperature and pressure measurements may be taken anywhere in the auxiliary feed system that provides representative data for the meter location. Units should refer to standardized methods such as the American Gas Association reports on gas metering or the appropriate ASME MFC reports for the unit's type of meter for additional guidance. A separate temperature and pressure reading is not required if the flow metering is already compensated for these factors, so pressure- and temperature-compensating metering may be the easiest solution for most units. Auxiliary fuel metering readings should also be recorded concurrent with the start and stop of each test run.

5.0 REPORTING

Test reports should include the information as outlined in Sections 1 through 4 of this protocol and include, to the maximum possible extent known, the date or manufacture of each incinerator, as well as the date of any post-manufacture modification or control device installation. A copy of the complete test report and supporting data will be provided to the designated AOGA/AMA/CPAI contact for data collection and analysis. Testing sites will provide one copy of each emission test report and supporting data to the designated EPA contact for review.